

WHAT IS CLAIMED IS:

1. A thin-film magnetic head comprising:  
an antiferromagnetic layer;  
a pinned layer exchange-coupled to said  
5 antiferromagnetic layer so as to have a fixed  
magnetization direction;

a free layer having a magnetization direction  
changeable depending on an external magnetic field; and

10 a nonmagnetic layer disposed between said pinned  
layer and said free layer;

wherein a sense current flows in a thickness  
direction of said free layer;

said pinned layer including a multilayer part  
comprising:

15 a first layer formed from Cu;

a second layer formed from Cu and disposed closer  
to said free layer than is said first layer; and

20 an intermediate layer, disposed between said  
first and second layers while in contact therewith,  
comprising a partly oxidized ferromagnetic layer.

2. A thin-film magnetic head according to  
claim 1, wherein said oxidized part in said  
intermediate layer of said multilayer part is a  
ferromagnetic material.

25 3. A thin-film magnetic head according to  
claim 1, wherein said intermediate layer of said

multilayer part is formed from Fe or FeCo.

4. A thin-film magnetic head according to claim 1, wherein said pinned layer comprises a first ferromagnetic layer exchange-coupled to said antiferromagnetic layer so as to have a fixed magnetization direction while in contact with said antiferromagnetic layer, a second ferromagnetic layer having a magnetization direction opposite from that of said first ferromagnetic layer, and a nonmagnetic spacer layer disposed between said first and second ferromagnetic layers;

said multilayer part being included in said second ferromagnetic layer.

5. A thin-film magnetic head according to claim 1, wherein said multilayer part comprises a plurality of multilayer parts.

6. A thin-film magnetic head comprising:  
an antiferromagnetic layer;

a pinned layer exchange-coupled to said antiferromagnetic layer so as to have a fixed magnetization direction;

a free layer having a magnetization direction changeable depending on an external magnetic field; and

a nonmagnetic layer made of Cu and disposed between said pinned layer and said free layer;

wherein a sense current flows in a thickness

direction of said free layer;

said pinned layer including a multilayer part comprising:

a first layer formed from Cu; and

5 an intermediate layer, disposed between said first layer and nonmagnetic layer while in contact therewith, comprising a partly oxidized ferromagnetic layer.

10 7. A head gimbal assembly comprising a thin-film magnetic head;

said thin-film magnetic head comprising:

an antiferromagnetic layer;

15 a pinned layer exchange-coupled to said antiferromagnetic layer so as to have a fixed magnetization direction;

a free layer having a magnetization direction changeable depending on an external magnetic field; and

a nonmagnetic layer disposed between said pinned layer and said free layer;

20 wherein a sense current flows in a thickness direction of said free layer;

said pinned layer including a multilayer part comprising:

a first layer formed from Cu;

25 a second layer formed from Cu and disposed closer to said free layer than is said first layer; and

an intermediate layer, disposed between said first and second layers while in contact therewith, comprising a partly oxidized ferromagnetic layer.

8. A hard disk drive comprising a thin-film magnetic head;

said thin-film magnetic head comprising:

an antiferromagnetic layer;

a pinned layer exchange-coupled to said antiferromagnetic layer so as to have a fixed magnetization direction;

a free layer having a magnetization direction changeable depending on an external magnetic field; and

a nonmagnetic layer disposed between said pinned layer and said free layer;

wherein a sense current flows in a thickness direction of said free layer;

said pinned layer including a multilayer part comprising:

a first layer formed from Cu;

a second layer formed from Cu and disposed closer to said free layer than is said first layer; and

an intermediate layer, disposed between said first and second layers while in contact therewith, comprising a partly oxidized ferromagnetic layer.

9. A thin-film magnetic head comprising:

an antiferromagnetic layer;

a pinned layer exchange-coupled to said antiferromagnetic layer so as to have a fixed magnetization direction;

5 a free layer having a magnetization direction changeable depending on an external magnetic field; and

a nonmagnetic layer disposed between said pinned layer and said free layer;

wherein a sense current flows in a thickness direction of said free layer;

10 said pinned layer including a multilayer part comprising:

a first layer formed from a nonmagnetic electrically conductive layer;

15 a second layer formed from a nonmagnetic electrically conductive layer and disposed closer to said free layer than is said first layer; and

an intermediate layer, disposed between said first and second layers while in contact therewith, comprising a partly oxidized ferromagnetic layer.

20 10. A magnetoresistive device comprising:

an antiferromagnetic layer;

a pinned layer exchange-coupled to said antiferromagnetic layer so as to have a fixed magnetization direction;

25 a free layer having a magnetization direction changeable depending on an external magnetic field; and

a nonmagnetic layer disposed between said pinned layer and said free layer;

wherein a sense current flows in a thickness direction of said free layer;

5        said pinned layer including a multilayer part comprising:

        a first layer formed from a nonmagnetic electrically conductive layer;

10        a second layer formed from a nonmagnetic electrically conductive layer and disposed closer to said free layer than is said first layer; and

        an intermediate layer, disposed between said first and second layers while in contact therewith, comprising a partly oxidized ferromagnetic layer.

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